Low-Fluence Electron Yields of Highly Insulating Materials

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Project supported in part
by the following missions

James Webb Space Telescope

Solar Probe Mission

Radiation Belt Storm Probe

JPL Solar Sail Research

International Space Station

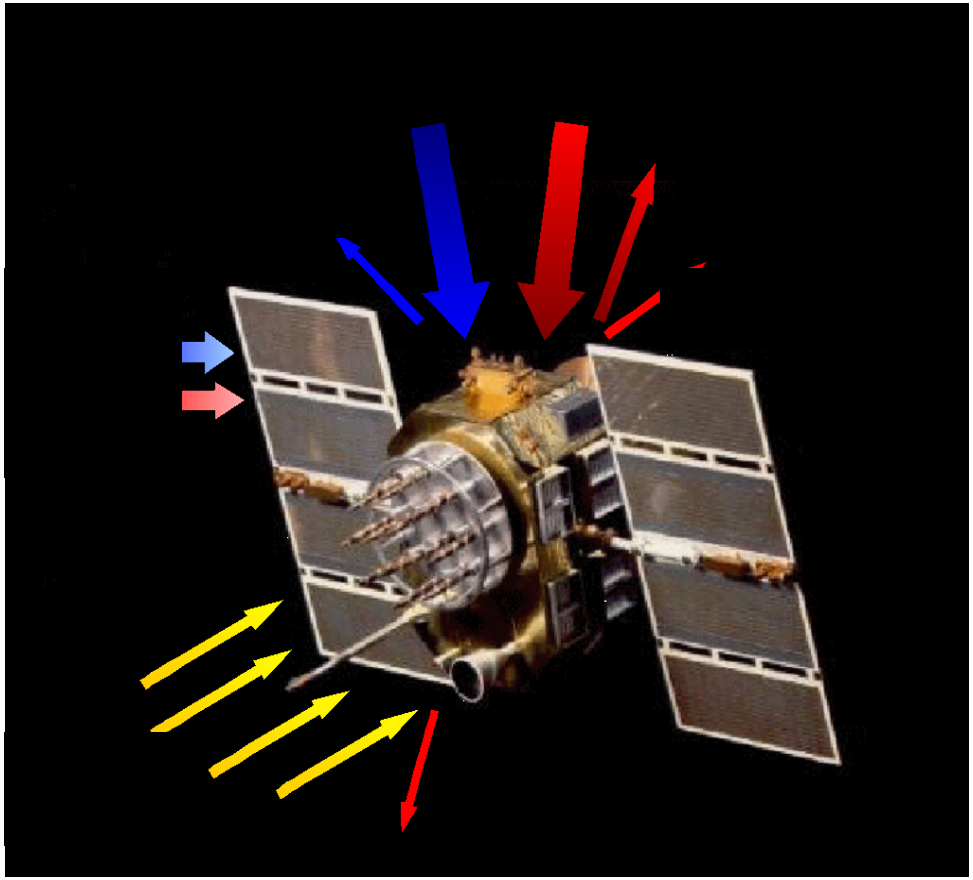
NASA SEE Database

Spacecraft Charging

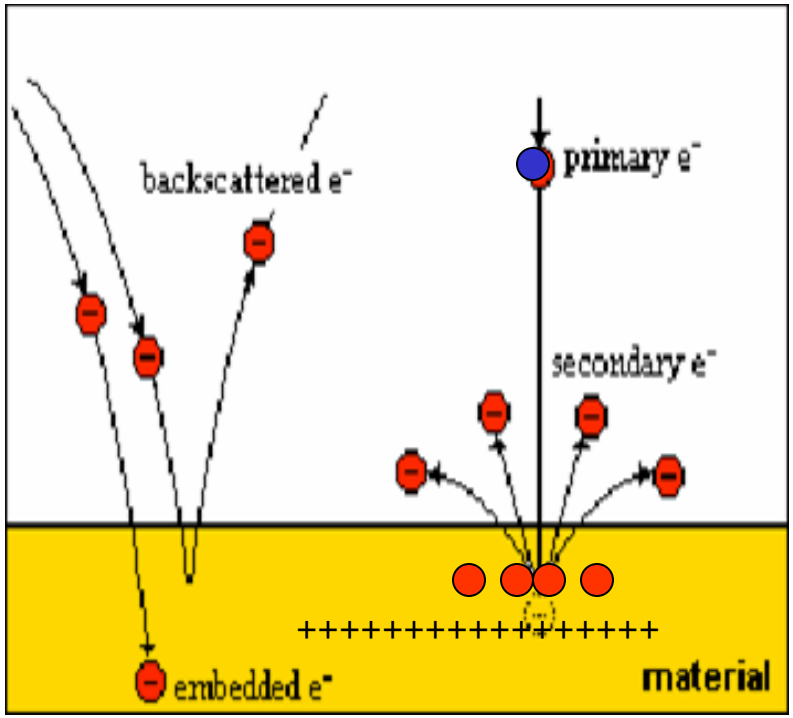
Charging Causes Anomalies

Phantom Commands

Total System Failure



Insulators Yields are Hard to Measure



$$Yield = \frac{e^-_{out}}{e^-_{in}}$$

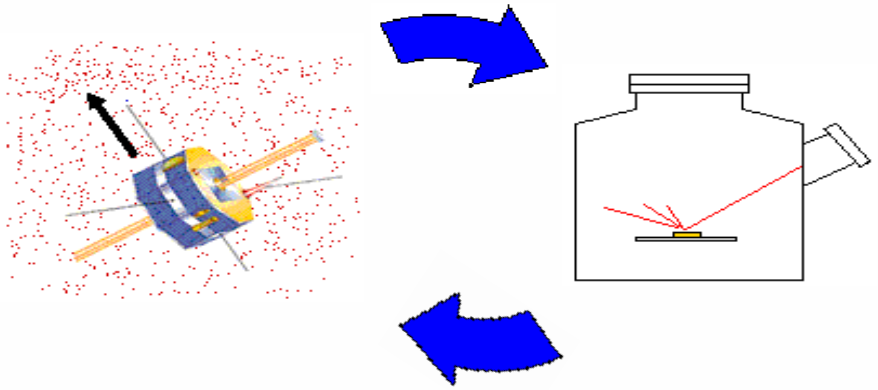
Yield = 1 No Charging
Yield > 1 Positive Charging
Yield < 1 Negative Charging

Our Relation to Charging Code

NASCAP 2k

SPENVIS

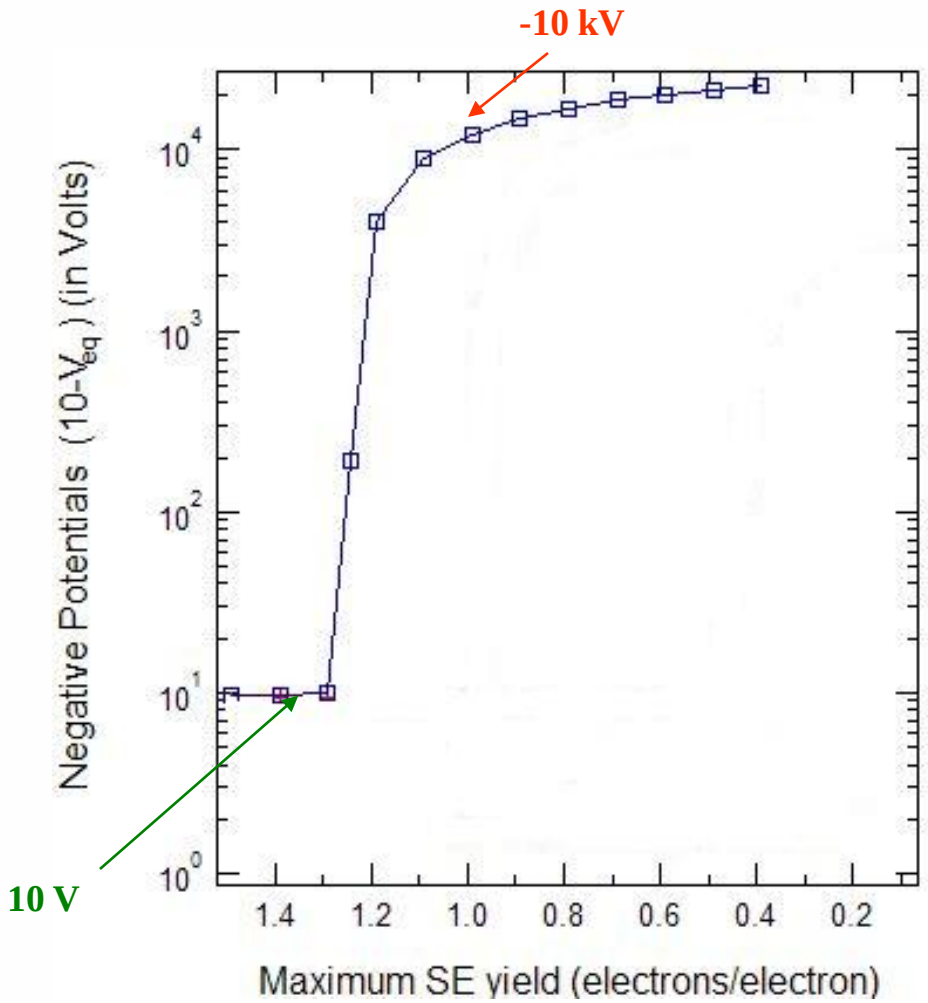
MUSCAT



Materials Properties are the Weak Point!

Triggering Threshold Charging

Small changes can cause large potentials

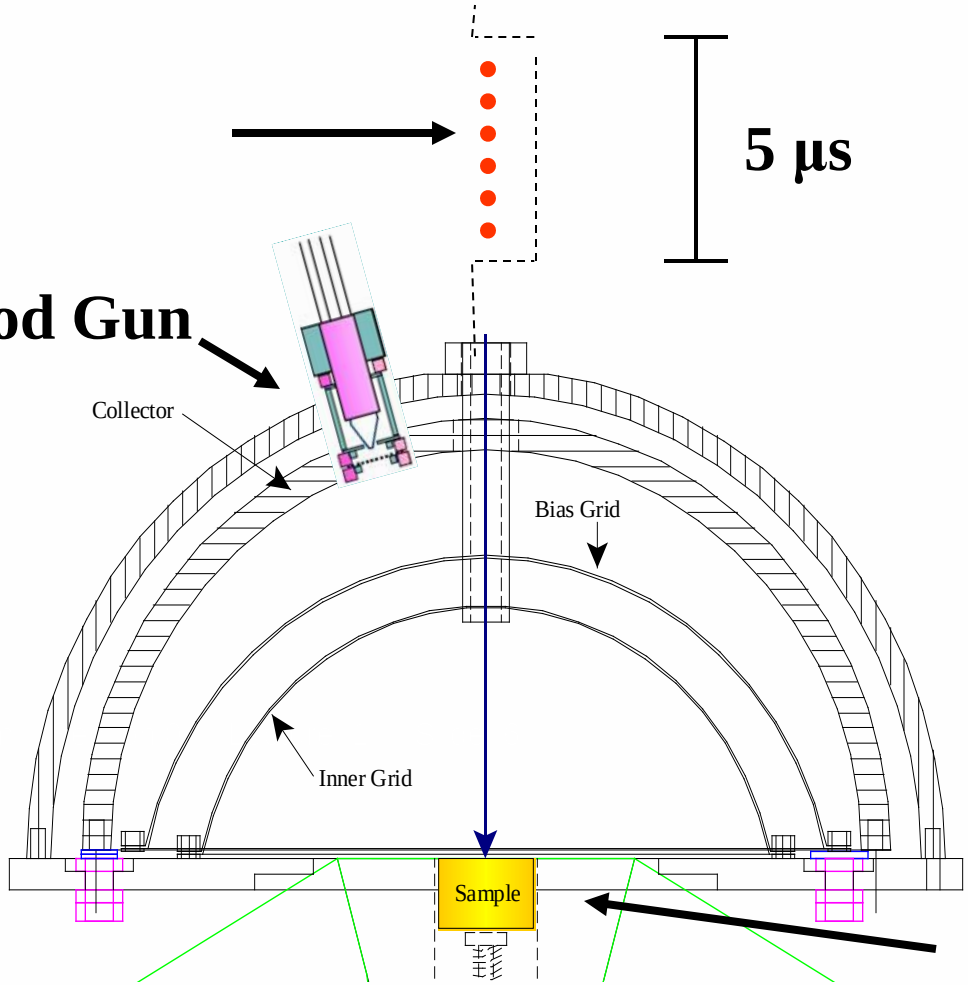


Instrument

$2*10^4$ electrons

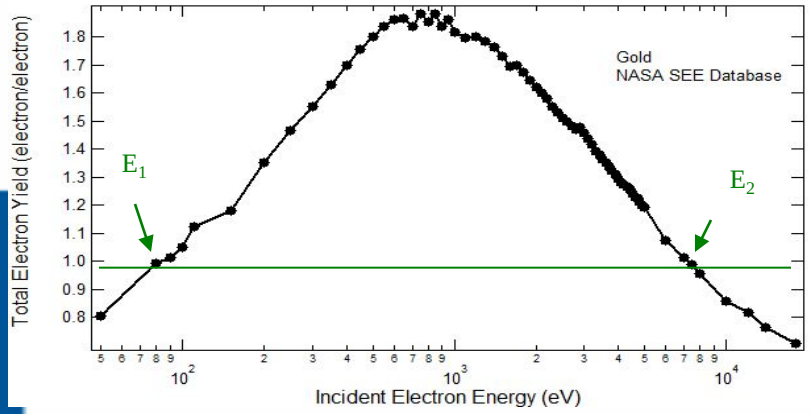
5 µs

Low Energy Flood Gun

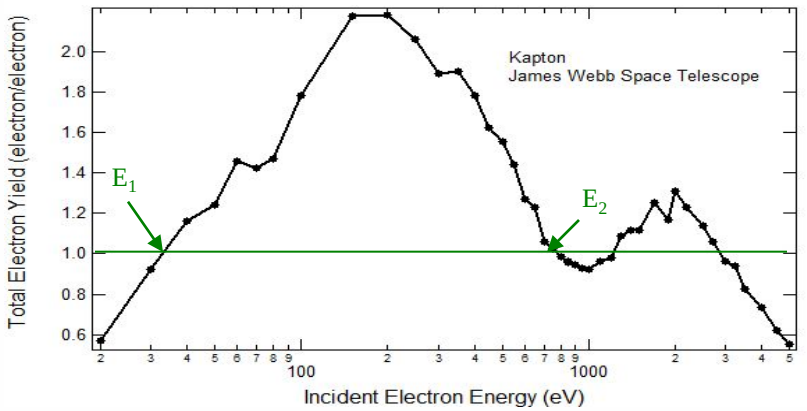


Sample

Representative Data

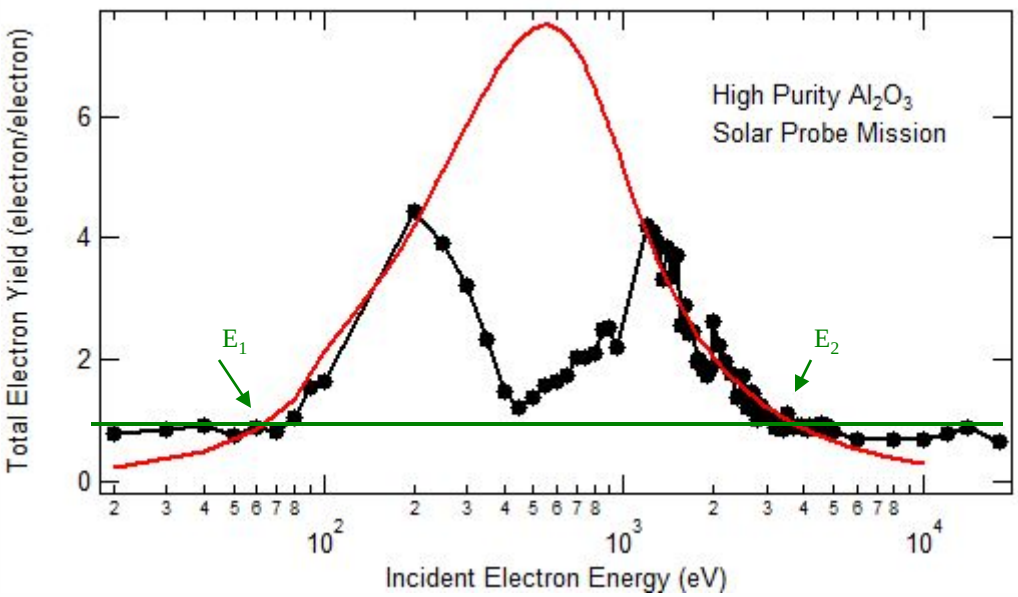


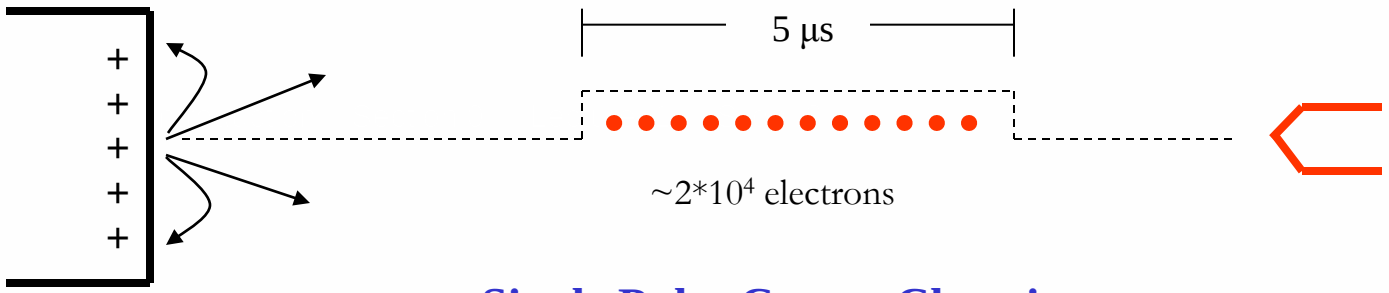
Low-Yield Conductor



Low-Yield Good Insulator

High-Yield Good Insulator

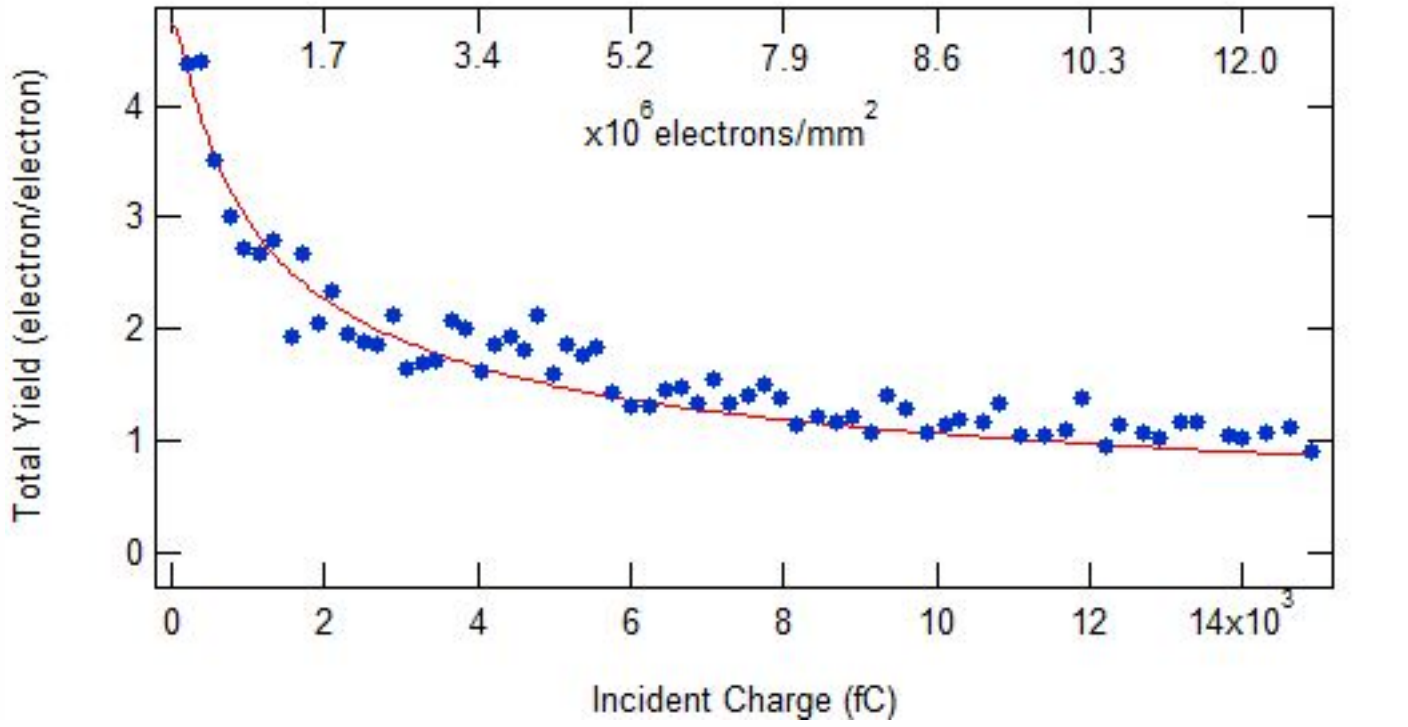




Single Pulse Causes Charging

Decay Curve for Al_2O_3

Allow charge to build up



Intrinsic (uncharged) yield is given when Q→0

The Goal ?

$$\delta(eV_s) = ??$$

$$\sigma(E_0, Q) = \delta(E_0) + \eta(E_0, Q)$$

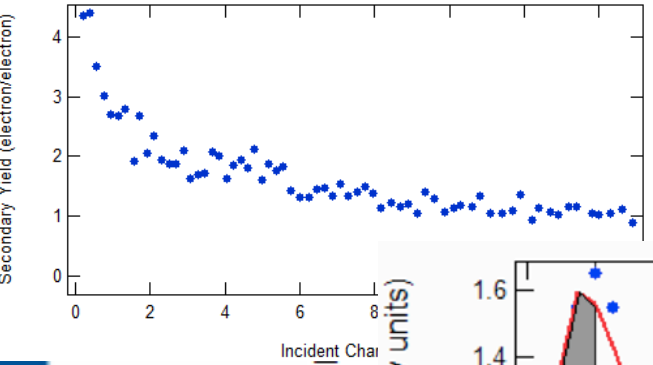
$$V_S = \frac{Q_0(\sigma - 1)}{C_1} - \frac{\sigma Q_0(\lambda_{SE} + R)}{C_2}$$

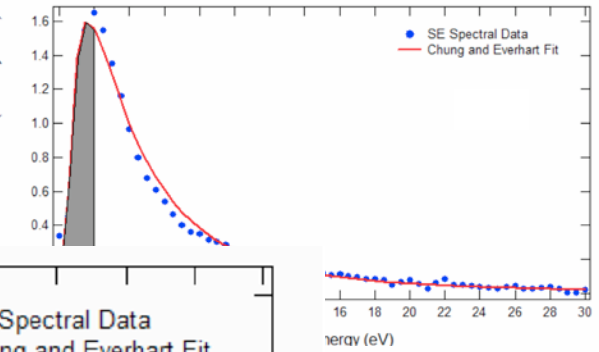
$$\frac{\delta_i(E_0, Q_i)}{\delta_0(E_0)} = \frac{\int_{50eV}^{eV_S} \frac{dN(E; E_o)}{dE} dE}{\int_{0eV}^{50eV} \frac{dN(E; E_o)}{dE} dE}$$

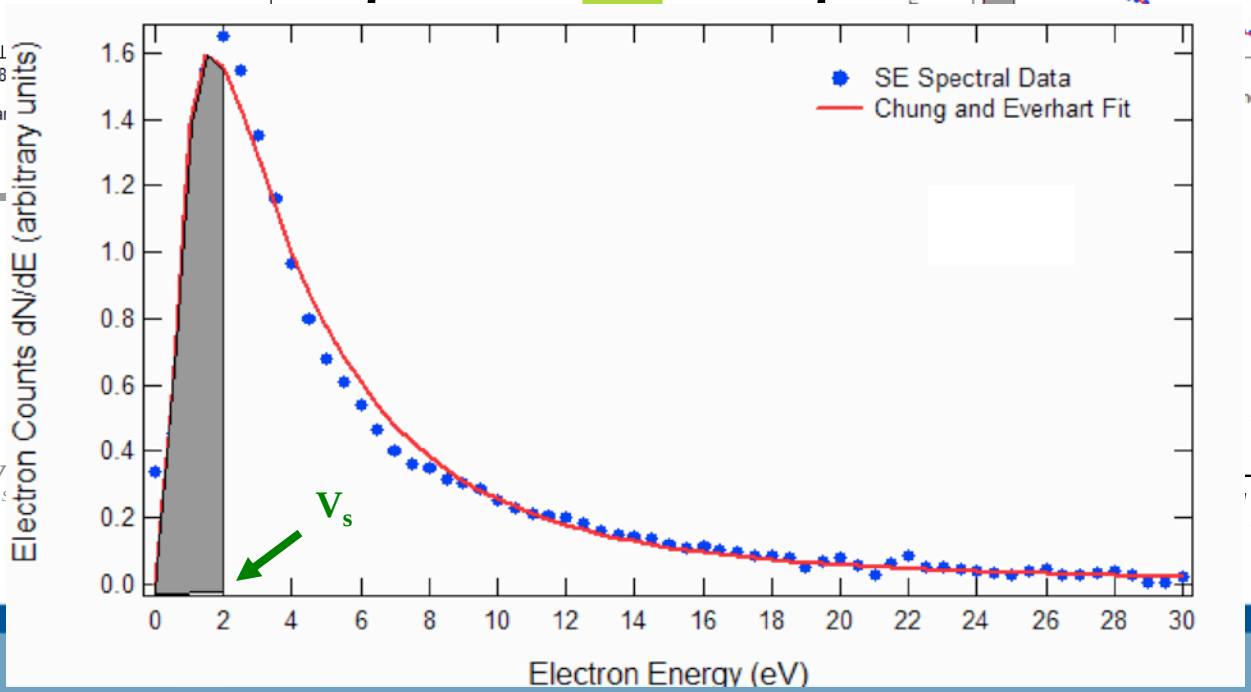
$$\delta(eV_S) = \frac{\delta_i(E_0, Q_i)}{\delta_0(E_0)} = \frac{\int_{50eV}^{eV_S} \frac{dN(E; E_o)}{dE} dE}{\int_{0eV}^{50eV} \frac{dN(E; E_o)}{dE} dE}$$

Total Yield → Surface Potential → Effective Yield

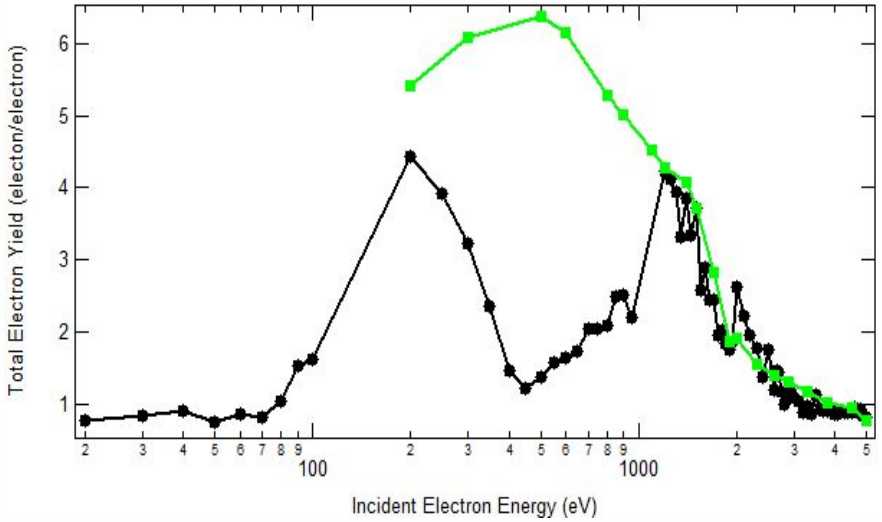
Model (PDPM)

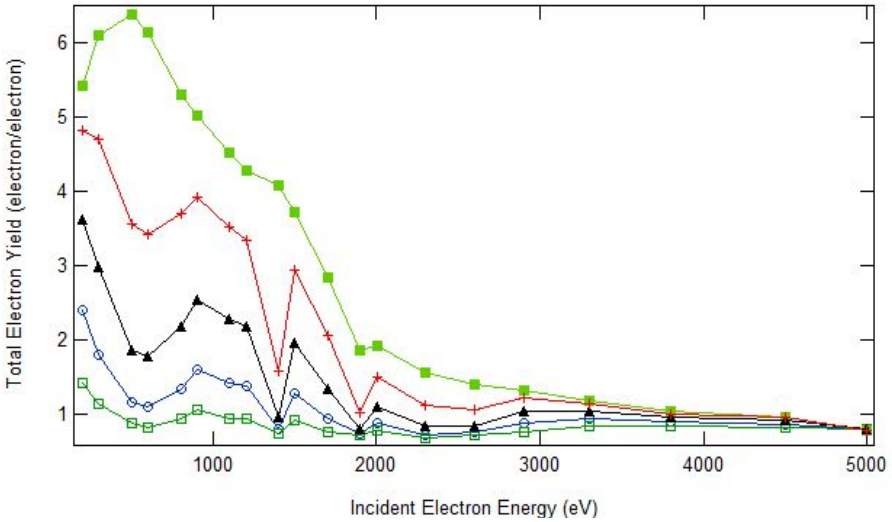






Predicted Yield Curves at Various Surface Potentials





- **Measured Yield**
- **Analytic Prediction as Q→0**
- **Analytic Prediction as V_s= 0, 2, 5, 10, 20 V**
- **Notice Predicted Duel-Peak**

Summary

Pulse Flood Measurements

+

Improved Modeling

New Method of Measuring Yield

+

Improved Spacecraft Modeling

+

Improved Mission Success Rate